

**UNITED STATES PATENT APPLICATION**

*of*

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*for*

**GEAR ARRANGEMENT**

## GEAR ARRANGEMENT

### BACKGROUND OF THE INVENTION

The present invention relates to the field of gear arrangements, and in particular to gear  
5 arrangements constructed of dissimilar materials.

Gear arrangements are known for example from German patent DE1961982. The gear  
combination disclosed in this German patent provides gears that rotate on a common shaft, and the  
teeth of one gear are arranged side by side relative to the teeth of another gear. The larger gear is  
made of plastic and the smaller gear is made of metal. Both gears are arranged stationarily and  
10 fixedly relative to one another on the shaft, for example with a key and keyway. Similar gear  
arrangements are disclosed in German patents DE2602152A1, DE3026685A1, DE846192C and U.S.  
Patent 3,719,103. In the above-cited gear combinations the gears made of different construction  
materials are, in contrast, rigidly fixed on the shaft or fixed, for example cemented to one another,  
15 with their surfaces facing toward one another. In this way slipping of the gears relative to one  
another in the direction of rotation is impossible.

In transmissions, gears engaging with one another transmit force and torque. However, the  
engagement of the teeth of the gears with one another causes disturbing and sometimes rather loud  
and unpleasant noise. For noise damping, the gears can be made of suitable materials such as plastic.  
Further noise reduction can be achieved by helical toothing of the gears.

20 While gears made of plastic are distinguished by the advantage of less noise, they have the  
disadvantage of lower strength. Similarly, gears made of metal display high strength but produce  
relatively loud noise. For transmission gears, one therefore seeks to find a material that produces

low noise but has the requisite strength requirements. Therefore, there is often a design compromise between higher strength versus less noise.

Therefore, there is a need for improved gear arrangements.

## 5 SUMMARY OF THE INVENTION

Gear arrangement having first and second gears made of two different materials sit loosely on a common shaft or common axis so that slipping of the gears sitting next to one another in the direction of rotation of the two gears is possible independently of one another.

By the loose arrangement of the gears on the shaft an asymmetric alignment of the toothings relative to one another comes about in the load case. The elasticity of the softer gear, for example the gear made of plastic, can be utilized for the deformation over a wider range, and also more safely than in the prior art because the softer material is not hindered in its deformation by a mechanical connection to the more rigid gear. This circumstance increases the damping properties and reduces the risk of damage. This risk of damage is, however, great in the case of the known gear combinations in which the gears are rigidly connected to one another, because stress cracks or notch effects can occur at the places of connection of the gears rigidly connected to one another. If the gears in the case of the prior art are fastened to one another with feather-key keyways, these damages can occur at these feather-key keyways.

An advantage of gear arrangements of the invention is that expensive and laborious techniques for connecting the gears to one another can be avoided. In addition, the gear combinations can also be used where connection of the gears has not been possible for reasons of

space. Furthermore, precise radial alignment of the toothings relative to one another is not required.

The gears having greater elasticity are preferably made of plastic, while metal is preferably chosen as the material for the gears having greater strength.

One embodiment of the second gear (e.g., a metal gear) exhibits a slightly smaller toothing  
5 than the first gear (e.g., a plastic gear) while having the same modulus. Therefore, under normal loading only the first gear made of plastic stands in engagement with another gear. As the load becomes greater, for example in the event of an overload, the first gear made yields in the elastic range so that the second gear made of metal also comes into engagement and can accept the high forces that now occur. In this way the first gear made of plastic is safely protected against  
10 overloading and fracture.

A further embodiment of the invention provides for a combination of three gears lying next to one another on a shaft, the two outer gears exhibiting greater elasticity than the middle gear or vice versa. The outer gears are preferably made of plastic or metal, while the middle gear is made of metal or plastic.

15 The gears are preferably helically toothed. The teeth of the gears lying next to one another can for example line up. The gears arranged next to one another can, however, also be slightly offset relative to one another.

In normal operation, the noise level is low because only the gears made of plastic are in engagement with one another. In the case of high load, the noise level increases somewhat because  
20 now the gear made of metal is engaged with another gear. Therefore, the noise level is a measure of the loading of the gears and can therefore be employed for measurement purposes. For example, a

recalibrated acoustic level meter can display the loading of the gears.

These and other objects, features and advantages of the present invention will become more apparent in light of the following detailed description of preferred embodiments thereof, as illustrated in the accompanying drawings.

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#### **BRIEF DESCRIPTION OF THE DRAWING**

FIG. 1 is a perspective view of a gear arrangement;

FIG. 2 is an enlarged detail of a portion of the gear arrangement illustrated in FIG. 1;

FIG. 3 illustrates an asymmetric alignment of the gears of the gear arrangement illustrated in

10 FIG. 1; and

FIG. 4 illustrates a side view of a gear arrangement that includes these gears.

#### **DETAILED DESCRIPTION OF THE INVENTION**

FIG. 1 illustrates a gear arrangement 10 that includes a first gear 12 and a second gear 14.

15 The first gear 12 is arranged immediately adjacent to the second gear 14. The first gear 12 is preferably made of plastic, while second gear 14 is made of metal. The second gear 14 has a slightly smaller toothing than the first gear 12, while having the same modulus. For ease of illustration, the shaft on which the gears 12 and 14 sit is not drawn.

FIG. 2 shows an enlarged detail from FIG. 1 in which the different toothing of the two gears  
20 12 and 14 is emphasized. The second gear 14 does not come into engagement until the first gear 12 made of plastic yields in the elastic range. The thickness of the first gear 12 is preferably chosen to

be greater than that of the second gear 14.

Referring to FIG. 3, the gears 12, 14 can turn independently of one another because of their loose arrangement on the shaft. In case of load, this leads to a situation in which the front sides of both the gears 12, 14 align relative to one another and no projection A arises. Front faces 1a and 2a of the gears 12, 14 respectively line up with one another. In contrast, on the back of both the gears 12, 14 (i.e., on the side of the gears 12, 14 facing away from the direction of rotation) a projection B is formed at the transition from back 1b of the first gear 12 to back 2b of the second gear 14. As shown in FIG. 3, the tooth depth of the second gear 14 is slightly smaller, for example by an amount C, than the tooth depth of the first gear 12.

Another embodiment is shown in side view in FIG. 4. A first gear 20, a second gear 22, and a third gear 24 sit loosely or rigidly on a common shaft 26. The elasticity of the first gear 20 and the third gear 24 is chosen to be greater or smaller than that of the second gear 22, whose strength is chosen to be greater or smaller than the strength of both the outer gears 20 and 24. The first gear 20 and the third gear 24 are preferably made of plastic or metal, while metal or plastic is provided as material for the middle gear 22. As in the previous embodiments, the toothing of the middle gear 22 made of metal having the same modulus is chosen to be slightly smaller than in the case of the two outer gears 20 and 24 made of plastic. The middle gear 22 can, however, also be made of plastic while both outer gears 20 and 24 are made of metal. In this case the toothing of both the outer gears 20 and 24 having the same modulus is chosen to be slightly smaller than in the case of the middle gear 22. The mode of functioning of the third exemplary embodiment illustrated in FIG. 3 corresponds to that of the previous embodiments. The gears 20, 22, and 24 are preferably helically

toothed.

The gear arrangement according to the invention is generally suitable for transmissions, for example for planetary transmissions. Advantageously, transmissions having gear arrangements according to the invention are distinguished by a low noise level and high overload protection.

5        Although the present invention has been shown and described with respect to several preferred embodiments thereof, various changes, omissions and additions to the form and detail thereof, may be made therein, without departing from the spirit and scope of the invention.

What is claimed is: